TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology in Conjunction with Kenya Institute of Highways and Building & Technology (KIHBT)

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

HIGHER DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING

EEP 3213: ELECTRICAL MACHINES

END OF SEMESTER EXAMINATION
SERIES: MAY 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*

This paper consists of **FIVE** questions. Answer question **ONE (Compulsory)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE**
00000000 printed pages

Question One (Compulsory)

a) State the function of the following parts in a DC generator.
   (i) Magnetic frame (yoke)
   (ii) Field coil
   (iii) Commutator
   (iv) Pole shoes **(4 marks)**

b) With the aid of suitable sketches, distinguish between:
   (i) Two layer and single layer windings
   (ii) Lap winding and wave winding
   (iii) Fall pitched and fractional pitched winding **(6 marks)**

c) A series DC motor has the following information.
   Armature voltage = 220v Mo of conductors = 800
   Ms of poles = 4 Load = 8.2kW
   Winding type = Lap I_{4n} = 45A
   Flux per pole = 25mWb Armature resistance = 0.6Ω

   $$T_a \frac{0.159\phi ZIP}{C}$$

   (i) Show that Torque developed is given by hence calculate Torque developed.
   (ii) Calculate the minimum supply voltage required if the total field resistance is 50Ω

Question Two

a) Draw a flow chart showing distribution of losses in a generator **(4 marks)**

b) Describe the procedure of conducting Hopkinson's Test **(6 marks)**

c) A 500V, 30kW shunt motor has a maximum efficiency of 90% and a speed of 600rpm when delivering 80% of its rated output. The resistance of shunt field 100Ω, determine with current intake of 78A.
   (i) Motor efficiency
   (ii) Motor speed

d) With the aid of a labeled diagram describe the functions of at least SIX parts of a conventional hydropower generating station **(6 marks)**

e) A dam has an outlet vertical pipe linking to a hydro-generator. The total length of the pipe is 50m while its diameter is 1.5m. The speed of water just before action on the turbine is 3m/s. The electrical

   $$\delta = 1000 kg/m^2$$

   and mechanical efficiencies of the system is 0.9 and 0.75. Use g = 9.81m/s^2 and to calculate.
   (i) The total kinetic and potential energy of water
   (ii) The output power of the hydrognerate
   (iii) The maximum demand of the load factor is 30%

Question Three

a) Draw circuits for the following single phab motors.
   (i) Resistance start split phase
   (ii) Capacitance start induction run
   (iii) Capacitance start capacitance run
   (iv) 'Kick start' single phase motor **(4 marks)**

b) With the aid of sketches and equations explain the "Double-Field Revolving Theory" **(6 marks)**

c) A 0.3kW, 240V HZ capacitor start motor has the following constant:

Main winding	
$R_m = 4.5\Omega$	Auxiliary winding
$X_m = 1178H$	$Ra = 9.5\Omega$
	$XLa = 11.14mH$

   (i) Determine the value of capacitance required to be placed in the auxiliary winding to make current be 90^o out of phase to that in main winding.
   (ii) Using phasor diagram, show the initial and connected voltage verses current condition

Question Four

a) State the relationship existing between the following 3-phase induction motors
   (i) Supply voltage, Torque and speed
   (ii) Supply frequency, Torque and speed
   (iii) Torque and slip
   (iv) Supply voltage and starting Torque **(4 marks)**

b) A certain 3-phase induction motor circuit has the following data:

Voltage supply = 400v
Stator impedance = 0.44j1Ω
Roto impedance referred to stator = 0.6 + 51Ω
Magnetizing Branch (10 + j 50 Ω)

With the aid of suitable sketches describe:

   (i) Draw the initial and determine the reduced circuit equivalent
   (ii) Find maximum torque developed
   (iii) Calculate slip at maximum torque
   (iv) Power factor when slip = 5%

Question Five

a) State FOUR important points that govern level of synchronous generator excitation with increasing load **(4 marks)**

b) (i) Explain FOUR kinds of Torques associated with a synchronous motor
(ii) Describe how a synchronous motor is started **(6 marks)**

c) A Y connected synchronous alternator has synchronous impedance of $(1 + j10)\Omega$/phase its excitations such that the generated emf is 14kv. Given that the alternator is 11kv, 5MVA machine connected to an infinite bus

(i) Determine the maximum output at the given excitation

(ii) Draw the phasor diagram depicting the situation **(10 marks)**